Remediation Progress of the High-Risk 618-10 Burial Ground at Hanford - 12427

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ABSTRACT

The 618-10 Burial Ground was in operation from 1954 to 1963 and consists of 94 vertical pipe disposal units (VPUs) and 12 solid waste disposal trenches. Remediation of the trenches began in March of 2011 under the River Corridor Closure Contract (RCCC)[a]. This work was considered to be high risk because the trenches are known to contain a large radiological inventory and have the potential to release airborne contaminants. Remediation is being performed without a containment structure by using a combination of engineering controls and monitoring equipment. The engineering controls include storing material below grade using a surge trench, the application of soil fixatives, and applying material storage limits. The use of radiological and chemical monitoring equipment is also used to provide near real-time information to guide remediation activities and limit contact of waste until risks can be evaluated. Remediation of the trenches is progressing without any significant personnel or environmental issues.

INTRODUCTION

The 618-10 Burial Ground, as shown in Figure 1, contains high-dose material (> 1,000 mR/hr) and plutonium-contaminated waste. It is believed to be the highest risk (i.e., for environmental or personnel exposure) burial ground remediated to date under the RCCC. The trenches are being remediated without the aid of a containment structure using a combination of engineering controls and chemical and radiological monitoring equipment. Remediation of the trenches began in March 2011 and is schedule to be completed in late 2012. The project has not experienced any significant environmental releases, exposures, or lost-time injuries to date.

The selected remedial action for this burial ground requires the contaminated material to be excavated and transported to the Environmental Restoration Disposal Facility (ERDF), located in the 200 Area of the Hanford Site. The ERDF is a double-lined landfill that has both a primary and secondary leachate collection system and an engineered cover. It has been designed to provide long-term containment of radioactive and hazardous waste. Before disposal at ERDF, waste must be sorted to remove prohibited items or land disposal restricted waste.

[a] The River Corridor Closure Contract (RCCC) is a the $2.3 billion 10-year contract managed by Washington Closure Hanford, LLC., a limited-liability corporation owned by URS Corporation, Bechtel National, and CH2M HILL under contract to the U.S. Department of Energy.

Fig 1. Location of the 618-10 Burial Ground and site facilities.

Hanford Background

A brief summary of Hanford's operations is provided for a better understanding of the nature and types of burial ground waste. The Hanford Site, located in Washington State, encompasses 1,517 km^2 (586 mi^2) and is divided into three major areas.

- The 100 Area is located at the north end of the site and contained nine plutonium production reactors built between 1944 and 1963. Eight of these reactors were removed from operation by 1971. The last reactor (100-N) was shut down in 1986.

- The 200 Area is centrally located and contained the chemical processing facilities used to separate plutonium from the irradiated fuel elements and the high-level waste storage tanks.

- The 300 Area is located at the south end of the Hanford Site and housed (in 1943) the research facilities and fuel fabrication facilities required to support the construction of the first production reactor. It later evolved to contain numerous research facilities for plutonium refining, irradiated fuel examination, plutonium extraction pilot tests, and radioisotope research. Between 1944 and 1957 more than 1,000 research tests were performed in the 300 Area.[1] Many of these tests produced unique waste that was sent to the 618-10 Burial Ground for disposal.

The production of fuel elements involved numerous processing steps in which uranium billets were heated, extruded into rods, cut to the appropriate length, and then cladded. Numerous waste streams were generated from the process, including metal turnings (aluminum, stainless steel, beryllium, zirconium, and depleted uranium), cutting oils, solvents, and spent industrial equipment. During the years the 618-10 Burial Ground was in operation, approximately 30,000 fuel elements were produced weekly.[1] [2]

618-10 Burial Ground Operating History

The 618-10 Burial Ground consists of 12 trenches and 94 VPUs. The trenches range in size from 97 m (320 ft) long by 21 m (70 ft) wide to 15 m (50 ft) long by 12 m (40 ft) wide. It began receiving waste in 1954 and was closed in late 1963. The generalized subsurface profile of the burial ground consists of Holocene-aged active and stabilized dune sand overlying Quaternary-age outburst flood deposits of the Hanford formation consisting of silt, sand, and gravel. All of the trenches were unlined and backfilled with native soil after being filled. Additional detail on the construction of the VPUs can be found in the cited reference.[3]

The 618-10 trenches received the majority of their waste from the 300 Area and some small quantities from other government agencies and universities. The 300 Area waste included low-level waste (LLW), mixed low-level waste (MLLW), and high-dose (> 1,000 mR/hr) waste associated with reactor fuels development facilities. The trenches also received a number of concreted drums that potentially contain transuranic[b] (TRU) quantities of waste. Material that is suspected of being TRU is being separated and characterized for disposal at the Waste Isolation Pilot Plant in Carlsbad, New Mexico.

METHODS

A detailed search of historical records was made to estimate the types and quantities of waste sent to this burial ground. The record search included the review of radiological survey reports, facility disposal records, status reports, and other facility records. After determining the types and quantities of waste, a remediation design was developed to address the perceived risks.

Summary of Waste Expected in the Burial Ground

Waste sent to the disposal trenches can be divided into two general categories: drums and miscellaneous waste. Drums include a wide variety of material from phyrophoric metal turnings to chemicals that were containerized before disposal. Miscellaneous waste includes process equipment, tanks, laboratory waste, gloveboxes, and construction debris. A discussion of these waste forms is provided below.

Drums

A total of 2,255 drums are estimated to have been disposed in the 618-10 Burial Ground. A breakdown by drum type is provided in Table I.

[b] WIPP Land Withdrawal Act of 1992, P. L. No. 102-579, 106 Stat. 4777, as amended by the WIPP LWA Amendments of 1996, P. L. 104-201, 110 Stat. 2422.. Transuranic waste is defined as waste containing alpha-emitting transuranic (atomic numbers greater than uranium [92]) radionuclides with half-lives greater than 20 years and concentrations greater than 100 nCi/g (3.7 MBq/kg).

Table I. 618-10 Drum Inventory Based on Historical Records.

Drum Type	Estimated No.
Concrete	972
DU Black Oxide	178
DU Chips/turnings	537
Zirconium	47
Thorium	40
Miscellaneous	480
Total	2,254

Concreted drums were generated from the disposal of waste in the 300 Area laboratories. Waste was generally loaded into a 30-cm (8-in.)-diameter culvert placed in the center of a 208-L (55-gal) drum. The culvert was capped with a lead plug and the drum was then filled with concrete. Waste disposed in concrete drums included high-activity waste and plutonium-contaminated liquid. Some of these drums also had up to 5 cm (2 in.) of lead shielding. To date, 65 concreted drums have been recovered; most have been in good condition. Two deteriorated drums were found to contain numerous bottles.

Black uranium oxide was generated by the thermal treatment of uranium mill turnings to form an oxide. Incomplete oxidation of the uranium presents a significant handling risk. Uranium chips that have not completely oxidized can ignite when exposed to the atmosphere. Remediation work conducted at the Idaho National Environmental Laboratory has had several incidents in which drums of uranium oxide erupted in a flash fire. These incidents could have resulted in injuries if personnel had been in close proximity to the events.

Uranium and zirconium metal turnings were generated from fuel element fabrication. Both are pyrophoric and present an airborne exposure risk should they become ignited. Typically, uranium and zirconium turnings were packaged in 115-L (30-gal) drums. For stabilization, the uranium turnings were immersed in cutting oil often containing polychlorinated biphenyls (PCBs). The zirconium chips were packaged in a water/oil mixture before disposal. To date, 38 drums containing depleted uranium chips have been recovered.

Drums containing thorium-contaminated waste were received and disposed in the burial ground in 1955. These thorium drums were shipped from the U.S. Department of Interior, Bureau of Mines Albany Metallurgy Research Center at Albany, Oregon, where thorium metal was arc melted and machined.[4]

Drums containing miscellaneous waste such as unknown chemicals and liquids, demolition debris, and laboratory glassware are also expected to be found in the 618-10 Burial Ground.

Miscellaneous Waste

Other waste disposed in the trenches includes bottles, shipping casks (i.e., transportation pigs), gloveboxes, hot cells, tank, processing equipment, and metallurgical samples of spent fuel. Radiological and chemical hazards include, but are not limited to, cesium, strontium, plutonium, americium, neptunium, uranium, beryllium, lead, zirconium, and deactivated sodium-potassium metals.

Working with beryllium containing waste in the U.S. Department of Energy (DOE) complex has recently undergone increased awareness. Extensive beryllium monitoring has been conducted at the 618-10 Burial Ground, and all results with the exception of one anomaly have been below requirements. The 10 *Code of Federal Regulations* (CFR) 850 requires workers who enter a beryllium control area (BCA) to have special training and medical monitoring.[5] To meet these requirements, equipment entering or leaving a BCA is wiped down and sampled. Beryllium sampling is conducted monthly in eating and change areas and workers receive medical surveillance monitoring for beryllium exposure.

Historical information is limited on the bottles sent to this burial ground. The bottles are suspected of containing a wide variety of waste from unused laboratory chemicals and radionuclides including cesium and plutonium. Handling bottles presents safety risks such as the potential for a fire or explosion or being a source of alpha contamination. During remediation activities at the 618-2 Burial Ground, two radiological control technicians received a significant alpha uptake when taking a smear on a laboratory beaker.[6]

Burial Ground Characterization Activities

Several geophysical surveys have been performed on the 618-10 Burial Ground to locate the burial trenches and the VPUs. The most recent survey showing the location of metallic debris is shown in Figure 2. In August 2010, intrusive characterization was performed in several locations shown in Figure 2. The intrusive characterization confirmed the location of drums in the northwest and southwest corners of the burial ground and found numerous bottles. No unusually high air or radiological sample results were recorded during the characterization.[7]

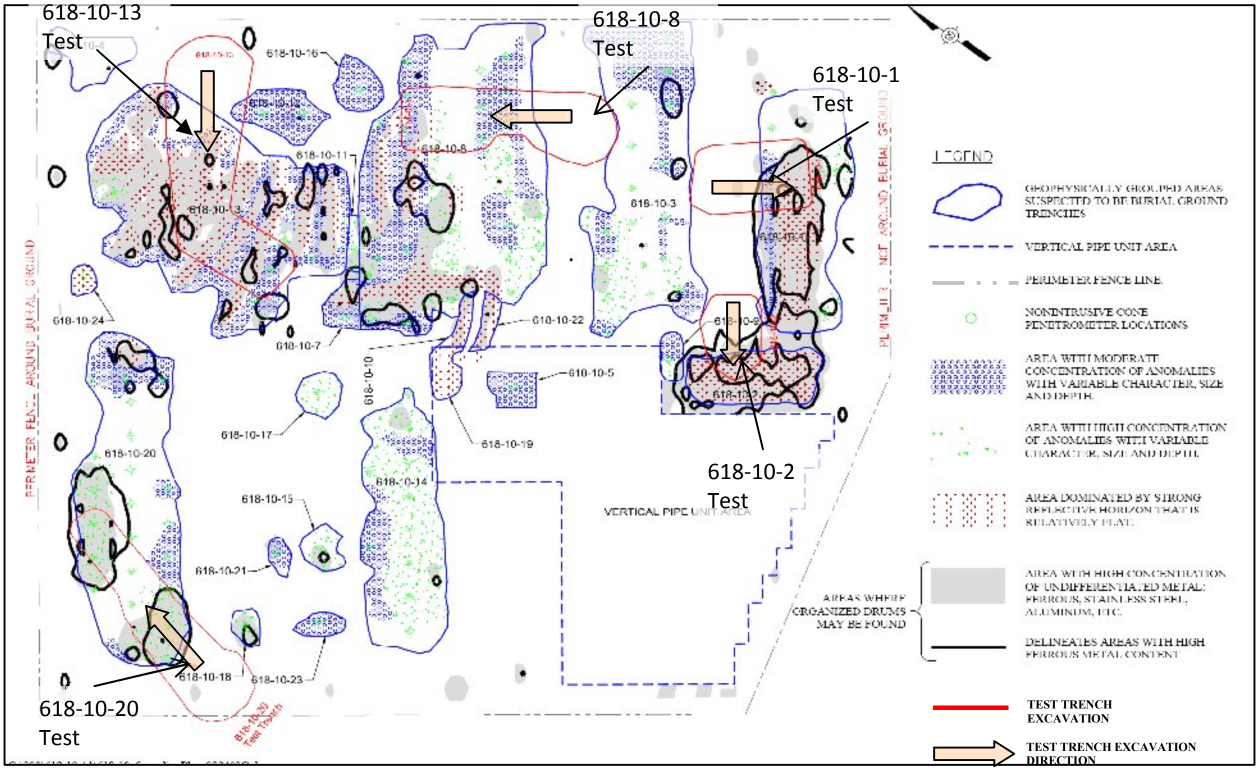

Fig 2. Geophysical survey of the 618-10 Burial Ground.

Remediation Design

The remediation design for the 618-10 Burial Ground was developed over a 2-year period. Much of the design is based on past experience with Hanford nuclear site burial grounds, including the burial grounds located along the Columbia River corridor.

Final Hazard Categorization

Results from the historical records search were used to prepare the final hazard categorization that determined the 618-10 Burial Ground was below a Hazard Category 3 nuclear facility in accordance with 10 CFR 830, Subpart B.[5] The hazard classification estimated the trenches contained 368 Ci composed mainly of Cs-137, Sr-90, Th-240, Pu-239, Pu-240, Pu-241, U-234, U-238, and Am-241. The estimate takes into account nearly 2,000 Ci of radioactive decay.[7]

Open Excavation Remediation Design

The remediation design for the 618-10 Burial Ground centers on an open excavation with a number of engineering controls utilized to minimize risks to the workers, public, and environment. Development of the controls was based on experience gained from previous Hanford nuclear site burial ground remediation experience, including evaluations of operational parameters and past practices from a number of Hanford remediation projects utilizing open excavation designs.[8] [9] In addition, safety evaluations were performed in conjunction with the development of the final hazard categorization and a fire protection evaluation.[10] [11] Some of the engineering controls developed as part of these analyses include the following:

- Limiting the size of active excavation
- Limiting the size of drum accumulation areas
- Using a below-grade excavation method (surge trench)
- Minimizing airborne radiological levels with application of fixatives
- Remotely handling uncharacterized waste
- Using a drum penetration facility (DPF) to open and inspect drums
- Crushing bottles directly in a Portland cement mix.

The prevention and minimization of exposure risks during remediation is lessened by the use of controls that limit the amount of contaminated materials (e.g., soil and drums) being manipulated at any given time, and control of airborne particulates (e.g., dust). One key engineering control utilized is limiting the volume of material being excavated at any given time to less than 390 m^3 (511 yd^3). This requirement minimizes the volume of material that could be involved in a fire or explosion. Another related control was to limit the size of groups of drums to 16 or less. The 618-10 Fire Protection Analysis further limited the number of uncharacterized drums staged at any accumulation area to no more than four drums.[10] A revision to the final hazard categorization allowed the spacing of drum accumulation areas adjacent to each other, provided they are separated by 0.6-m (2-ft)-wide concrete barriers.

Limiting burial ground excavation and sorting operations to occur only below grade also greatly reduces the potential for contamination spread out of the burial ground. To accomplish this a surge trench is constructed in a clean area adjacent to the burial ground, as shown in Figure 3. Material excavated from the burial ground is sorted to remove drums, land disposal restricted waste, and other material that is not acceptable for disposal at ERDF. The sorted material (minus the unacceptable waste) is then cast into the surge trench in 5-m (16.4-ft) passes. After each pass, a clean soil cover is placed over the surge trench to provide wind protection. At a later date the sorted material can then be loaded out for transport to ERDF. The material that is unacceptable for ERDF disposal must be characterized and sent to an appropriate offsite treatment facility. After treatment, some of this waste may be returned to the Hanford Site for disposal at ERDF.

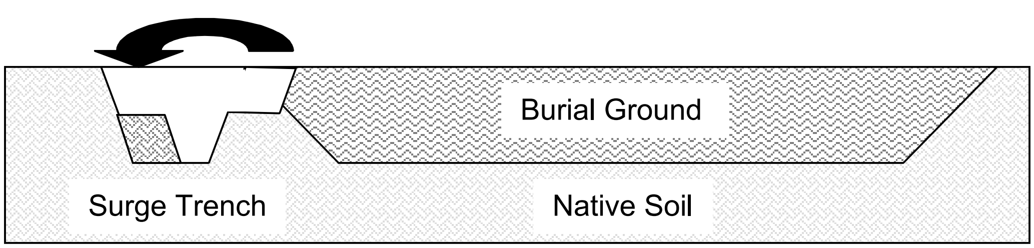

Fig 3. Cross section of surge trench adjacent to the burial ground.

During the sorting process a soil/dust fixative is applied to the contaminated soil using water cannons. This minimizes dusting problems both during the sorting process and later when the material is loaded out. Control of dust is vital to preventing the spread of contamination outside of the burial ground. Dust monitors are used whenever excavation or sorting operations are occurring in the burial ground. In addition, excavation or loading operations are halted in the burial ground if wind speed exceeds a 32 km/hr (20 mi/hr) base on a 15-minute average.

Radiological air monitors are also used around the perimeter of the burial ground. The filter papers from the monitors are collected daily at the end of operations. An alpha count is performed on the filter papers; the results must clear before starting the next day's operations. The clearing process involves verification that alpha contamination is associated with naturally-occurring radon and not other radionuclides. By daily reviewing the radiological monitoring results, the effectiveness of dust control measures can be evaluated and adjusted. To date, the highest air monitoring was associated with Pu-239 and Am-241 contamination measured at around 7 total derived air concentration units. The source of this high reading could not be determined but is believed to be associated handling bottles.

Monitoring

Real-time monitoring instrumentation is also used to provide an early indication that waste may be reactive or a potential contamination hazard. Excavators that handle burial ground waste are equipped with a multi-gas detector, a dose monitoring instrument, and an infrared temperature sensor. The gas detector and the dose instrument are continuously monitored at a remote location. Due to the risk of handling pyrophoric drums, the infrared temperature sensor is used to check drums for elevated temperatures before handling. The real-time monitoring instrumentation provides a means for early response in the event a pyrophoric or hazardous material is detected. For added protection the excavator and other equipment that transport waste are equipped with a blast-resistant windshield cover.

Beryllium monitoring and controls have been established in accordance with 10 CFR 850.[5] Beryllium monitoring is conducted through air monitoring and physical sampling prior to the relocation of drum overpacks from the beryllium contamination area around the burial ground to the long-term drum storage area.

Utilization of a Remotely Operated Drum Penetration Facility

One of the highest risk waste forms is the opening and characterization of unknown drums. To assist with drum characterization a remotely operated DPF is used. The DPF provides a contained environment in which a drum can be punched, visually inspected, monitored, and stabilized before sampling. The DPF operates on a negative air pressure and passes discharged air through a high-efficiency particulate (HEPA) filter before it is vented to the atmosphere. It is equipped with a video monitor system and radiological and gas monitoring equipment. After puncturing the lid, a video camera can be used to inspect the drum contents. Mineral oil or water can be added to stabilize drums that contain potentially pyrophoric metal turnings. A new DPF (Fig 4) was specially designed and built for the 618-10 project with the following improvements: a lift table that can be adjusted in the horizontal or vertical direction before punching, the addition of an alpha detection meter, a more compact design, and the conversion to all hydraulically operated equipment.

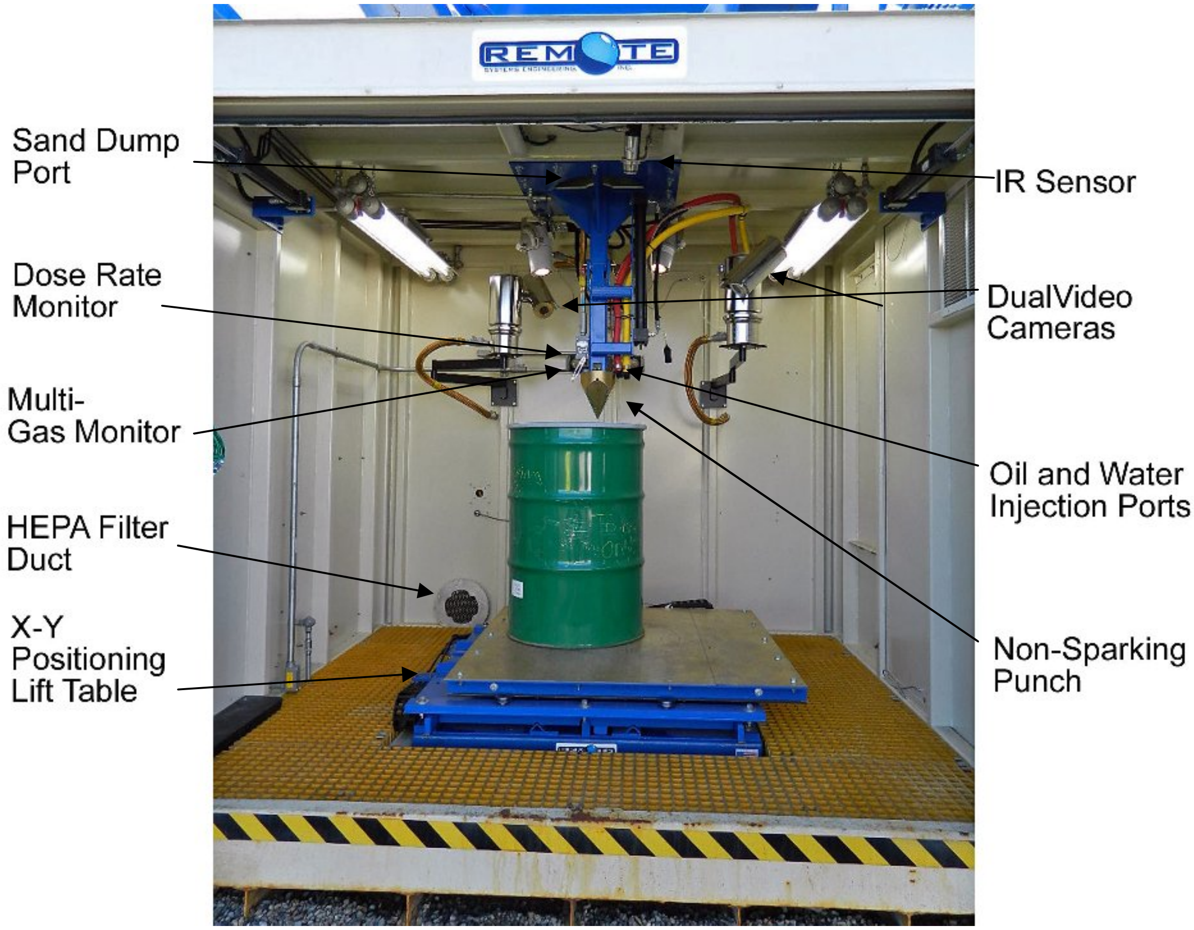

Fig 4. New drum punch facility for the 618-10 Burial Ground.

Bottle Handling Process

Bottles present a significant challenge to remediation operations. As part of previous Hanford River Corridor burial ground remediation operations, bottles were collected intact from the excavation and containerized in a drum. The bottles were later placed in a plastic container and then remotely crushed using the DPF. The contents of the bottle were retrieved from the plastic container and then sent to a laboratory for analysis. Often the characterization process consumed the entire contents of the bottle.

Upon evaluation of the contamination incident that occurred at the 618-2 Burial Ground, it became evident that a new method should be developed for handling bottles. Due to the potential for bottles to contain reactive chemical or plutonium solutions, Washington Closure Hanford obtained DOE and U.S. Environmental Protection Agency approval to solidify bottles directly in the trench. To accomplish this, when a bottle is found in the burial ground it is staged directly in a steel mixing box. After placement in the mixing box, the bottles are covered with a layer of soil. Once the mixing box is full (approximately 50 to 100 bottles), the bottles are removed and placed in another mixing box to be solidified. The bottles are added to the second mixing box in small groups not exceeding a volume of 4.5 L (1.2 gal) at a time. The bottles are crushed and thoroughly mixed in the grout mixture before adding more. After the bottles have been crushed, the grout is removed from the mixing box and placed in a disposal container. A sample is collected to verify that the solidified grout does not exceed the toxicity characterization leaching procedure limits for heavy metals.

Passive Neutron Detector

To facilitate the detection of plutonium contaminated waste, two large-area neutron detectors were specially fabricated for this project. Each detector measures 1 m (42 in.) by 0.7 m (27.5 in.) and contains nine He-3 tubes embedded in a polyethylene slab. The detectors can be operated individually or linked to count large items (e.g., drums). The detectors are calibrated to provide an accurate estimate of plutonium (g) in a gamma dose field of up to 1 rem/hr. The neutron detector provides a quick and accurate estimate of plutonium quantities in very heavily shield drums that may not be seen using a conventional gamma spectral analysis. All of the concrete drums recovered from the 610-10 trenches are counted on the neutron detector before proceeding off site for radiotomography.

High-Energy Real-Time Radiography (HE-RTR)

To facilitate the characterization of concrete drums, HE-RTR will be used to examine the contents of drums that cannot be easily opened or are believed to present an exposure risk if opened. The HE-RTR can also be used to examine the contents of unknown items (e.g., pigs) that are known to contain radiological waste. The HE-RTR is located in the 200 West Area of the Hanford Site. The HE-RTR facility was recently purchased by the DOE for the purpose of examining drums exhumed from the 618-10 Burial Ground and the 618-11 Burial Ground, a similar site located approximately 8 km (5 mi) to the north and east of 618-10. Drums will be transported to the HE-RTR in a U.S. Department of Transportation IP-2 approved shipping container. The 6-Mev x-ray HE-RTR system has been demonstrated to easily detect bottles or cans of liquid that may be present in the concrete drums. Drums that are indentified to contain liquids or other prohibited items will be sent to an off-site treatment facility to be opened and removed. After the prohibited item(s) have been removed the drum will be packaged for disposal for either the ERDF or the Waste Isolation Pilot Plant.

RESULTS

Project Remediation Progress and Status

Remediation of the 618-10 Burial Ground began in March 2011. Approximately 40% of the burial ground has been excavated and sorted as of December 2011. Approximately 70,000 m^3 (97,560 yd^3) of material remain to be excavated and sorted. Loadout of the sorted material is expected to begin in February 2012 and continue through the end of the calendar year. A significant number of drums still remain to be excavated and characterized. A total of 111 drums have been excavated and characterized as of December 2011. Table II presents a breakdown of the types of drums excavated thus far.

Table II. Drums Excavated and Characterized as of December 2011.

Drum Type	No. Excavated
Concrete	65
DU Black Oxide	0
DU Chips/turnings	38
Zirconium	0
Thorium	0
Miscellaneous	8
Total	111

Results of the characterization activity identified two of the concrete drums with significant Pu-239 concentrations (> 0.5 g Pu). Concrete drums containing plutonium concentration greater than 0.5 g Pu are considered suspect TRU and will undergo further evaluation to determine if they will be classified as TRU waste. The use of the neutron slab detector have instrumental in characterizing the concrete drums for Pu. No drums have been found with significant external dose measured at the drum surface. The highest contact dose encountered thus far is 100 mR/hr. No significant exposure events have occurred to workers or the environment based on environmental monitoring, personnel dosimetry, and industrial hygiene monitoring.

Significant progress was made toward the implementation of the bottle handling process during November and December 2011. Several field mockup tests were performed to refine the process and the crushing and subsequent grouting of bottles is expected to begin in January 2012.

The use of the HE-RTR facility depends on the project's ability to transport concrete drums to the 200 West Area of the Hanford Site. Progress is being made toward securing the appropriate equipment and vehicles. Prior to using the HE-RTR facility for examining concrete drums an acceptance test will be performed using a shielded test drum to mockup the same configuration expected in the concrete drums exhumed from the burial ground. The acceptance test will be performed in January 2012. Full use of the facility is expected to occur in February 2012.

Lessons Learned

Some important lessons learned from the 618-10 Burial Ground thus far include the following:

- Review of historical records to identify hazardous contents is crucial to developing the remediation design. If historical records are sparse, nonintrusive (e.g., geophysical methods) and intrusive characterization activities in the burial ground are necessary for identifying hazards and developing a design strategy.

- Through an evaluation of operations with similar materials at other DOE sites, the project should anticipate that short-term flash fires may occur and their source may never be determined. Workers and regulators should be briefed on emergency response actions to minimize costly downtime.

- Control of wind-blown dust and debris is essential to preventing airborne contamination releases. The use of a surge trench to keep sorted debris below grade is an effective method to control dust and potentially contaminated airborne particles. The generous application of dust fixatives during excavation and sorting operations performed in the arid and seasonal windy environment of southeastern Washington State provides adequate control of airborne dust and particulates, based on the results from daily air monitoring.

- The level of training for operators to overpack drums remotely using excavators has been increased over previous burial ground remediation campaigns. This method eliminates the need for workers to approach uncharacterized drums.

- Opening unknown drums remotely in a DPF eliminates many health and safety concerns. The ability to remotely extinguish a fire also provides added safety.

DISCUSSION

Remediation of the 618-10 Burial Ground is progressing with no significant personnel exposures or environmental releases. The remediation of the burial ground is being performed as an open excavation without the use of a containment enclosure. Two primary controls being utilized as part of the burial ground remediation to prevent the spread of airborne contamination in place of an enclosure include the following:

- Sorting of material below grade with use of a surge trench
- Application of dust fixatives applied liberally during remediation activities.

In addition to the controls listed above, air monitoring is performed to indicate the release of dust, metals, and radioactive particles. Air monitoring includes the following:

- Four fixed Hanford Site environmental air monitors, including the co-locating of four project initiated thermoluminescent dosimeters (TLDs)
- Three fixed project initiated near-field air monitors/TLDs
- Portable air monitors placed near daily remediation activities
- Personnel wearing industrial hygiene and radiation control breathing air monitors.

The use of a surge trench to store and sort waste material below grade until it can be loaded out, and the application of dust fixatives have prevented wind-blown contamination issues. No significant (above action level) airborne contaminants have been detected to date.

Characterization methods used for examining drums and anomalous items include a series of monitoring equipment beginning at the excavation and ending with analyses performed in the drum characterization and staging areas. Monitoring instrumentation located at the excavation includes the following:

- Excavator-mounted gamma radiation rate meter
- Excavator-mounted multi-gas monitor used to determine the presence of hazardous gasses such as volatile organic compounds, carbon monoxide, and cyanide
- Gamma spectral analysis (ORTEC® Detective gamma radiation spectroscopy).

Monitoring instrumentation located in the drum characterization and staging areas includes the following:

- Fixed gamma spectral analysis (ORTEC® Detective gamma radiation spectrometer), co-located with a scale used to weigh drums.
- Passive neutron slab counter, used to screen drums for potential Pu (TRU nuclides). The neutron slab counter is used as a binary, “go/no-go” decision point in the process. “No-go” represents the potential presence of Pu at >0.5 g and indicates and hold-point in the process where the drum will be subjected to further screening. Generally, only concrete drums are screened using the passive neutron slab counter.
- Drum penetration facility (DPF), used to screen drums with the purpose of determining Safe-to-Approach status – meaning the drum can be physically approached by project personnel for inspection and sampling. Monitoring instrumentation in the DPF includes a gamma radiation rate meter and a

multi-gas monitor. In addition to the radiological and chemical monitoring instrumentation, video cameras and a moveable platform allow a remotely located engineer and operator to view the contents of the drum after the drum lid has been breached.

- ISOCS® (In-situ object counting system) high-purity Germanium gamma radiation spectrometer. The ISOCS has a higher accuracy over the NaI gamma radiation spectrometer and is used to further examine the concrete drums to evaluate the presence of Pu (TRU nuclides).

A significant number of drums still remain to be excavated and characterized for disposal. Sixty-five concrete drums and thirty-eight depleted uranium drums have been discovered and characterized. The use of a DPF has eliminated many of the health and safety concerns associated with opening drums that contain potentially pyrophoric material.

Excavation operations at the burial ground are expected to be finished in the spring of 2012. Material loadout operations are expected to start in early 2012 and continue to the end of the calendar year. Remediation of the associated VPUs is not expected to occur until late 2012.

Much knowledge has been gained from the 12 years of burial ground remediation experience at the Hanford Site. Many of the lessons learned discussed in this paper may be applicable to other DOE sites and may result in significant time and cost savings if taken into consideration during a project's design and planning phases.

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